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NEW AND OLD VIEWS ON GLACIATION.

Die Gletscher. By Dr. Hans Hess, königl. gymnasial-Professor in Ansbach. Pp. xii+426. (Brunswick: F. Vieweg und Sohn, 1904.) Price 15 marks.

THE author of this closely written treatise reminds us that it is nineteen years since Heim issued his classical "Handbuch der Gletscherkunde," and that the numerous additions to our knowledge since 1885 may well be brought together in a convenient form. Dr. Hess has an intimate personal knowledge of European glaciers, on which he has made patient and numerical observations; and in the difficult matter of the theory of glacier-motion he has had the cooperation of Prof. Finsterwalder, of Munich. The work of Finsterwalder, indeed, is in many ways an inspiration throughout the book, but the references to Chamberlin, Brückner, Drygalski, Penck, Reid, and many others show what an immense amount of material has been added to our knowledge in very recent years.

In summarising the conclusions of these authors, the work of Dr. Hess becomes somewhat encyclopædic, and it will be felt, according to the idiosyncrasies of the reader, that certain subjects are unduly dwelt on, while others are summarily compressed. Those who live in countries that were at one time buried under confluent sheets of ice will wish to see an extended history of Polar and Alaskan glaciers, and a further discussion of the widely spread moraine-material which appeared on their melting and retreat. The mention (p. 388) of Kames and Eskers as " durch die Schmelzwasser geformte Hügel in den Schotterbänken" will hardly satisfy dwellers in Britain or Scandinavia, not to say the Prussian plain; nor does it represent the views recently accepted by Prof. Jas. Geikie, from whose work it is professedly a translation. We ought, however, to be willing to refer to memoirs on special districts when pursuing inquiries such as these, and we may well be grateful to Dr. Hess for the new details brought to our notice from the regions in which he himself has studied.

The book opens with a review of previous observation, in which priority is accorded to John Playfair for realising the meaning of erratic blocks so far back as 1802. The physical characters of ice are then discussed, and full stress is laid on the recognition of ice as a viscous body, yielding to pressures and adapting itself to its surroundings. Glacier-ice (p. 20) suffers some reduction in plasticity owing to the admixture of sand and dust. The discovery by McConnel and Kidd, and by Emden, of the plasticity of the individual ice-crystal led Emden (p. 316) to remark that a glacier consisting of a single crystal at the temperature of its melting point would move precisely as a granular glacier. Regelation, as an explanation of glacier-motion, though still holding its own in physical text-books, has been set by geologists in the second place in recent years. In the regeneration of fractured glaciers, however, as Hess points out, this phenomenon plays a most important part.

We could wish that the tenth section, on the theory of glacier-movement, had followed closely on the first, and had thus offered an explanation of much that is obscure in the earlier chapters of the book. The development of Finsterwalder's "Strömlinien" is greatly needed during the discussion of moraines, and readers of so special a treatise are naturally familiar enough with general physical geography and the form of glaciers to understand the exposition of Finsterwalder's views at an early stage. This exposition, from p. 325 onward, shows how every point in the surface of the firn-basin is connected by a "Strömlinie" with a corresponding point on the surface of the glacier lower down. The ice-particle enters the firn at one end of the line, by deposition from the atmosphere, and disappears from the glacier, by melting or evaporation, at the other end of the line. In between, it has had a course within the ice-mass, longer or shorter, according to the form of the rock-floor and of the bounding walls. The lower boundary of the firn marks the line of division between the area where the flow-lines enter the glacier and that in which they emerge upon its surface. While a "Strömlinie" never lies entirely on the glacier-surface, a "Bewegungslinie" is (pp. 138 and 327) the course of a stone dropped upon and remaining on the surface. Shortly, "Strömlinien" emerge at all points along "Bewegungslinien," but do not coincide with them.

Dr. Hess regards the stratified structure of glacier-ice as essentially arising, by natural conditions and irregularities of deposition, in the area of the firn; the appearance becomes intensified by streaming out and extension lower down (p. 173), but has nothing to do with internal pressures. Experimental evidence of this conclusion is provided. An interesting case of unconformity in the bedding of ice-layers is quoted and illustrated from Finsterwalder on p. 177.

The title of the seventh section, "Eis und Fels," reminds us that massive ice is as much one of the rocks of the earth's crust as desert-sand or a reef of coral. Marine limestones are, for instance, formed of material withdrawn from invisible solution in the sea; on one side they may receive almost molecular additions, on the other side they may disappear again by solution. An ice-mass is similarly added to or removed at different points, but it is none the less a rock. Its plastic behaviour, however, among other rocks has led us to think of it as a thing apart, just as we sometimes forget that mercury has a crystallographic form. The chapter in question will attract attention on account of its treatment of moraines, and the belief of the author in the rapidity of the erosion that takes place upon the glacier-floor. From personal observations, which are now being carried further, he estimates this erosion, in specially active cases, as indicating a reduction of the floor-level by 3 cm. per annum. Allowing for the additional influence of water-erosion, which he considers to be far less than that of the moraine-laden ice, he uses the figure of 3 cm., somewhat adventurously, in calculating (p. 376) the age of some of the larger valleys of the Alps.

A fine picture (p. 35) is given to show how the fissile structure of rocks affects their mode of weathering by the ice. The author holds that large blocks are re-

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moved from the walls and floor of glaciers wherever the planes of division lie at favourable angles. In this way, medial moraines have a very real existence below the surface of the glacier as well as upon it, since a rocky island yields ice-scratched material over its surfaces of contact with the ice that sweeps round it on either side. "Such medial moraines (p. 194) possess only ground-moraine material"; the word "only," however, seems negatived by the following sentence:—"their constituent débris is not limited to the surface, but reaches right down to the base. In consequence, the débris seen at the surface is not constant in quantity as in the pure medial moraines, but increases in proportion as the end of the glacier is neared, in accordance with the progress of ablation."

Internal moraines may similarly arise from projections in the firn-area; the fragments are carried forward as a wall within the ice. A little diagram on p. 203 makes Finsterwalder's scheme of moraine-structure clear, though it perhaps exaggerates the filmy character of the ordinary ground-moraine.

It has seemed to many geologists that the increasing stress laid on the plasticity of ice, and the ease with which it adapts itself to obstacles, make it all the more necessary to look to frost and storm, and to the erosive action of sub-glacial streams, as the agents by which glaciated hollows are cut out. The passages (p. 361 *et seq.*) on cirques—no such Gallic word is really admitted to this treatise—and the forms of Alpine valleys will show how much room there is for differences of opinion on this point. We fancy that the views put forward by Dr. Hess as to the simple "peneplain" character of the pre-Glacial Alpine slopes will receive considerable criticism from those who have described the successive movements along the mountain-axis in Miocene and Pliocene times. The grouping of the pre-Glacial river deposits of France and Switzerland, as they are traced back into the hills, should give us some idea of the depth of the valleys before the ice spread down into them. The work of rivers at the present day in rapidly destroying the Glacial troughs, and in carving out ravines on ice-worn walls, leads many of us to regard glaciers mainly as moulders and preservers of the basins which they temporarily fill. Dr. Hess, however, extends his support of the excavation-theory to the Scandinavian fjords (p. 388), and it is well to realise that these views, once widely prevalent, have not lost their hold upon men who can measure and observe.

Modern English writers may find their contentions somewhat slightly dealt with, and their names occasionally mis-spelt. Through a certain Teutonicism, moreover, the glacial terms familiar to three-quarters of the globe are omitted from the text and from the index. Scarcely any German work mentions *roches moutonnées*, made classical by De Saussure; but it is hard to see *nieves penitentes* admitted as a newcomer.

In conclusion, Dr. Hess has produced a book that must find a place in every scientific library, both as the work of an original observer and as a record of the active progress of geological research.

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MATHEMATICS FOR SCHOOLS.

Practical Geometry for Beginners. By V. Le Neve Foster and F. W. Dobbs. Pp. ix+96. (London: Macmillan and Co., Ltd., 1904.) Price 2*s.* 6*d.*

Elementary Algebra. Part i. By W. M. Baker, M.A., and A. A. Bourne, M.A. Pp. viii+275+lii. (London: George Bell and Sons, 1904.) Price 3*s.*

A New Trigonometry for Schools. Part i. By W. G. Borchardt, M.A., B.Sc., and the Rev. A. D. Perrott, M.A. Pp. vii+237+xxxv. (London: George Bell and Sons, 1904.) Price 2*s.* 6*d.*

The Elements of Plane Trigonometry. By R. Lachlan, Sc.D., and W. C. Fletcher, M.A. Pp. v+164. (London: Edward Arnold.) Price 2*s.*

Preliminary Practical Mathematics. By S. G. Starling, B.Sc., A.R.C.Sc., and F. C. Clarke, B.Sc., A.R.C.Sc. Pp. viii+168. (London: Edward Arnold.) Price 1*s.* 6*d.*

Constructive Geometry. By John G. Kerr, LL.D. Pp. 122. (London: Blackie and Son, Ltd., 1904.) Price 1*s.* 6*d.*

New School Arithmetic. Part i. By Charles Pendlebury, M.A., F.R.A.S., assisted by F. E. Robinson, M.A. Pp. xv+206+xxi. (London: George Bell and Sons, 1904.) Price 2*s.* 6*d.*

THE Practical Geometry by Messrs. Le Neve Foster and Dobbs consists of a collection of more than seven hundred examples, grouped in sets, each set illustrating some fundamental geometrical principle, the whole covering the subject-matter of Euclid, Book i. There is little or no descriptive matter, but the examples themselves are carefully selected and arranged, so as to lead the pupil by easy steps from experimental quantitative work, in which geometrical truths are discovered, to generalisations based on the knowledge thus obtained. In part i. the examples are entirely practical. In part ii. the work is partly deductive, and this section is intended to supplement the study of pure geometry, and especially to be used in conjunction with Mr. Allcock's "Theoretical Geometry for Beginners." These two parts are followed by a large number of miscellaneous examples and by twenty-six illustrations of geometrical patterns, in which the student finds scope for the application of the knowledge he has obtained. The book will be found very useful in supplementing any elementary text-book which is confined to the abstract reasoning of pure geometry.

A feature of the Algebra by Messrs. Baker and Bourne is the profuse supply of easy and well graduated examples provided at short intervals, enabling even the very backward student who works through them to acquire by almost insensible stages facility in the manipulation of algebraical symbols, and a sound knowledge of algebraical processes. Revision papers are given from time to time, by which he can test his progress. Considerable use is made of squared paper in the graphing of algebraical functions, the solution of equations, and in other ways, thus greatly adding to the interest of the work, and giving a better insight into the nature of the subject. This book is the first instalment of a larger work, to be completed in a second volume. It carries the subject up to the

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